END2END QUALITY ACCESS SELECTION

TECHNICAL FIELD

The present invention relates to multi-radio access systems in general, specifically to a method and an arrangement for access selection in such systems.

BACKGROUND

Many mobile communication stations, such as cellular phones, cordless phones, portable computers, digital assistants, pagers, and the like, now have the capability to access more than one access network. These access networks may include cellular networks such as Global System for Mobile Communications (GSM) and Wideband Code Division Multiple Access (WCDMA), direct wireless networks such as Bluetooth and Wireless Local Area Networks (WLAN), satellite networks, and the like. For example, some mobile communication stations can be used as both a cellular phone under the GSM specification or as a cordless phone under the Digital European Cordless Telephone (DECT) specification. An application in the mobile communication station may then select any of the available access networks to begin communicating with remote applications.

Each access network may provide a number of different services and features therein such as high-speed access, text messaging, call forwarding, and other similar features and services. The mechanisms for accessing these access networks may include radio frequency connections, infrared connections, modem connections, LAN connections, and other similar connections.

Several multi-access scenarios will exist in the near future, for example CDMA/WLAN. In many cases, more than one of the available accesses can carry the same end-user service. For example, best effort packet data can be carried by both

CDMA and WLAN. Consequently, at some point in time, a selection of which access to use must be done by the terminal or for the terminal.

In the prior art, it has been observed that the accesses are selected based on the quality available on the radio access, in [1] selection is based on the quality for a service. However, the radio link is not always the bottleneck for the access.

Accordingly, it is desirable to be able to provide a convenient way to select an optimal access network.

SUMMARY

An object of the present invention is to provide an improved access selection method in a multi-access system.

Another object is to provide a method of selecting an access based on an end-to-end quality of an access.

A further object is to provide a method for access selection based on a measured end-to-end quality for the whole communication path between a terminal and a destination node.

This object is achieved in accordance with the attached claims.

Briefly, the present invention comprises measuring an end-to-end quality for a plurality of available radio accesses and selecting at least one access based on the measured quality.

The access selection is based on end-to-end measurements through the whole communication path. The delay and/or bandwidth can for example be measured for all

accesses to select among by transmitting acknowledgeable measuring packets with equal or different packet-size.

Further, the invention comprises an arrangement and a system enabling access selection based on a measured end-to-end quality between a terminal and a destination node.

Some of the advantages of the present invention are:

- End2end best quality access selection for any type of network.
- Terminal based access selection that takes into account load and other limiting factors in any link in the communication path.
- Multi-operator access selection without any coordination between operators.
- No impact on infrastructure.
- Concurrent use of multiple access paths improving the maximum end2end quality.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

Fig.1 is a schematic illustration of a multi-access system;
Fig.2 is another schematic illustration of a multi-access system;
Fig.3 illustrates an embodiment according to the invention;
Fig.4 is a schematic flow diagram of an embodiment according to the invention,
Fig.5 illustrates an embodiment of an arrangement according to the invention.

DETAILED DESCRIPTION

The access selections described in [1] only takes the quality of the radio link into account. Since the radio path is only one link in a chain of communication links forming the path for the end-to-end service, this is a very limited approach. Even though the radio link often is the limiting link, it is not always the case. In a multi-access scenario, the core network is typically not uniform and the communication path between a terminal and a server can differ completely between two radio accesses.

Figure 1 shows a general multi-access system in which the invention can be implemented. It comprises at least one terminal that is able to communicate or utilize the services of a plurality of available access networks. In the illustration, the different accesses are exemplified with GPRS, WLAN and WCDMA. However, other types of access networks are also possible.

In Figure 2 another example of such a multi-access network is shown, in this case with a 3GPP based core network. Loose inter-working is assumed between WLAN and UMTS, i.e. only subscriber handling and security functions are reused from UMTS for the WLAN access and the user planes for WLAN and UMTS are completely separated

In such networks, there are a number of links that for different reasons can be the bottleneck for the end-to-end throughput and quality. The solution described in the prior art assume, as stated earlier, that the radio link always is this bottleneck.

However, as identified by the inventors, for access over WLAN the first wired link from the access point (AP) is often the limiting link in the communication path, e.g. between the AP and the L2/L3 switch in Figure 1. This is typically a T1 with 1.5Mbps in US and Canada, a J1 with 1.5Mbps in Japan or an E1 with 2Mbps in Europe, sometimes it can even be a DSL with 0.5Mbps or less. This wired link will then limit the quality for WLAN communication since the WLAN radio often has a higher throughput, up to 7Mbps with 802.11b and 26Mbps with 802.11a/g.

Similarly, other links in the network can also be limiting and may vary over time due to different reasons such as varying load.

Figure 2 further illustrates a scenario where the user plane for WLAN and UMTS/WCDMA is completely separated although one operator controls all accesses and has the possibility to perform network assisted or network controlled access selection. In [2] an even less coordinated network is described; namely so called *terminal control without any network assistance*. In such scenarios, a network controlled selection alternative is complicated.

According to the invention, a basic solution to find the best quality access is to measure the end-to-end quality through all candidate accesses to select among between a terminal and a destination node, not only the quality for the radio link. Subsequently, the measured results are compared and that access or those accesses that give the best end-to-end quality between the terminal and the destination node are selected.

The destination node can be an actual destination node such as another mobile terminal, or other device which the terminal can communicate with. Alternatively, the destination node can be an intermediated node that is common for some or all available accesses, such as a router or other service node

The term end-to-end quality typically refers to a user perceived quality, not the overall quality for the system.

Fig. 3 illustrates a scenario, in which the invention can be implemented, comprising a mobile communication terminal 10 requiring service from a destination node 30, and which terminal 10 has the option of selecting between the two access networks 20. In the embodiment, the two accesses are WLAN and WCDMA. However, the invention is equally applicable to any combination of different networks, operators or access

technologies, such as WLAN, CDMA, GPRS etc. Also, the invention is applicable to a situation where the terminal has to choose among more than two available accesses.

Fig. 4 illustrates a general method for access selection according to the invention. Assuming that there are a plurality of available accesses, these can be access points or base stations within one access network, or different access networks, or some other configuration.

Initially, in step S1, the end-to-end quality for each available access is measured for the whole communication path between a terminal and the destination node. The destination node can be an actual final destination node or an intermediate common node in the system.

The measuring step S1, according to an embodiment of the invention, comprises transmitting an acknowledgeable measuring packet from the terminal to the destination node. Upon receiving an acknowledgement, the end-to-end quality can be determined.

According to another embodiment, the measuring step S1 comprises transmitting an acknowledgeable measuring packet from an intermediate node to the terminal. Subsequently, the measurements can be signaled to the terminal.

The intermediate node can comprise a router or some other node in the system, which is utilized by a plurality of accesses.

The acknowledgeable measuring packet, according to a specific embodiment, can be a so called ping-probing packet [3] or a payload packet, or some other acknowledgeable predefined packet.

Finally, the measurements are compared and the access or those accesses that give the best end-to-end quality for the terminal is selected, in step S2, based on the measurements. For some cases it is quite possible to knowingly select an access that

dose not provide the best quality. A potential scenario is that the cost for accessing the best quality access is too high, thereby preventing selection of the best access.

According to yet another embodiment, both the measuring step S1 and the selection step S2 can be performed at an intermediate node. When a best access is selected, the terminal is then informed of the selection and ordered to utilize the selected access.

In a situation where two terminals communicate, the question is which terminal that should perform the access selection. According to one embodiment of the present invention, it is quite possible to let both terminals select its best access to a first common node between the terminals. In that case each terminal performs end-to-end measurements to the common node and selects the best access. It is equally possible for the common node to perform the measurements to each terminal and inform the terminals about the best access for their respective communication path.

The end-to-end quality for a communication path can typically be measured as a function of at least delay or bandwidth, or a combination thereof. This can be measured by transmitting acknowledgeable measuring packets with different packet sizes towards the destination IP-address or node. The probing can be done prior the session. It can also be done periodically during the session to make a change of access.

Another alternative probing method is to base the probing on some type of triggers, such as a predetermined lowest/highest quality threshold.

According to another embodiment the end-to-end quality is measured as a function of packet error rate. In that case, the measurements are performed by transmitting multiple probing packets or acknowledgeable probing packets with equal or different packet-size to each available access network.

The measuring packets can be so called ping-probes, but not necessarily so. Basically, any acknowledgeable data packet with a predetermined size can be utilized. Even part

of the actual data to be transmitted can be used. It is also possible, for some cases, to transmit some other type of payload packet.

According to another embodiment of the present invention, if the terminal is assigned one IP-address per access (multi-homing), a soft selection can be applied. All accesses to select among are loaded with a fraction of the load in order to measure the end-to-end quality. HTTP-sessions are suitable for this solution since they can consist of a number of TCP-flows. Then the best access is selected for most of the flows while the other accesses are just probed with one flow each. Or more advanced, load all accesses to increase the maximum possible end-to-end throughput. The load can be balanced or divided between N accesses according to:

$$L_n = \frac{1}{D_n \cdot \sum_{i=1}^{N} \frac{1}{D_i}} \cdot L_{tot}$$

where L_{tot} is the total load, L_n is the load or utilization for access n, D_n is the normalized round trip time in s/kbit for access n, and N is the number of accesses.

A numerical example of dividing the load or utilization from a terminal on more than one available access will now be described. According to the example, two accesses are available, one with 2Mbps throughput and the other with 1Mbps, that shall be loaded with a 60kbps service. A 1kbyte packet is sent on the first access resulting in a 4ms delay and a 1kbyte packet on the second access results in a 8ms delay. The normalized delays are; D_1 = 0.004s/kbit, D_2 = 0.008 s/kbit, resulting in L_1=40kbps and L_2=20kbps. Consequently, the data to be transmitted is divided on the two accesses according to L_1 and L_2.

In Fig. 5, a general embodiment of an arrangement such as a user terminal 10 according to the invention is illustrated. The terminal 10 comprises an input/output unit 11, a unit 12 enabling end-to-end quality measurements, and an access selection unit 13.

According to the embodiment, the measuring unit 12 is adapted to measure the end-to-end quality between the terminal and a destination node. The destination node can comprise an actual destination node, or an intermediate node that is common for all available accesses. The unit 12 is further adapted to perform the measurements by transmitting acknowledgeable measuring packets to the destination node, and upon reception of the acknowledgement determining the end-to-end quality for the access. The measurements can comprise delay and/or bandwidth and/or some other parameter.

According to another embodiment, the unit 12 is adapted to transmit multiple measuring packets with different packet size, and thereby enabling measuring packet error rate.

According to yet another embodiment, the end-to-end quality determining unit 12 is configured to receive measurements from another node. Alternatively, the unit 12 is further adapted to receive information of a best access, which is selected at some other node in the system, possibly a router.

The access selection unit 13 is adapted to select at least one access 20 based on the measured end-to-end quality for each available access from the terminal 10 to a destination node.

Additionally the invention comprises a node in a multi-access telecommunication system. The node comprises, a unit 12 enabling end-to-end quality measurements, and an optional access selection unit 13.

According to the embodiment, the measuring unit ~~12~~ is adapted to measure the end-to-end quality between a terminal and a destination node. The unit 12 is further adapted to perform the measurements by transmitting acknowledgeable measuring packets to the terminal, and upon reception of the acknowledgement determining the end-to-end quality for the access.

If the optional access selection unit 13 is included in the node, it is further adapted to signal or report the selected access to the terminal, thereby informing the terminal which access to use for a best end-to-end quality.

According to the invention, a system enabling access selection based on end-to-end quality measurements is provided. Accordingly, the system comprises a measuring unit 12 configured for measuring, for each access network, an end-to-end quality through a whole communication path from a terminal 10 to a destination node 30, and an access selection unit 13 adapted to select at least one access based on the measured quality.

The measuring unit 12 of the system is typically located in a mobile communication terminal or user equipment, but it is also possible to locate the measuring unit 12 in some other node and signal the measurements or accesses selected based on the measurements to the terminal.

It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the scope thereof, which is defined by the appended claims.

REFERENCES

[1] Patent: "Method of Multi-Service Allocation in Multi-Access Systems", WO 03/088686

[2] P. Magnusson et al, "Radio Resource Management Distribution in a Beyond 3G Multi-Radio Access Architecture", submission to Globecom 2004.

[3] www.ping127001.com/pingpage.htm